

Title : Basic Configurations of ROBOT

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Source of Information : Industrial Automation & Robotics by Er. A. K. Gupta & S. K. Arora, University Science Press, Laxmi Publishing Pvt. Ltd.

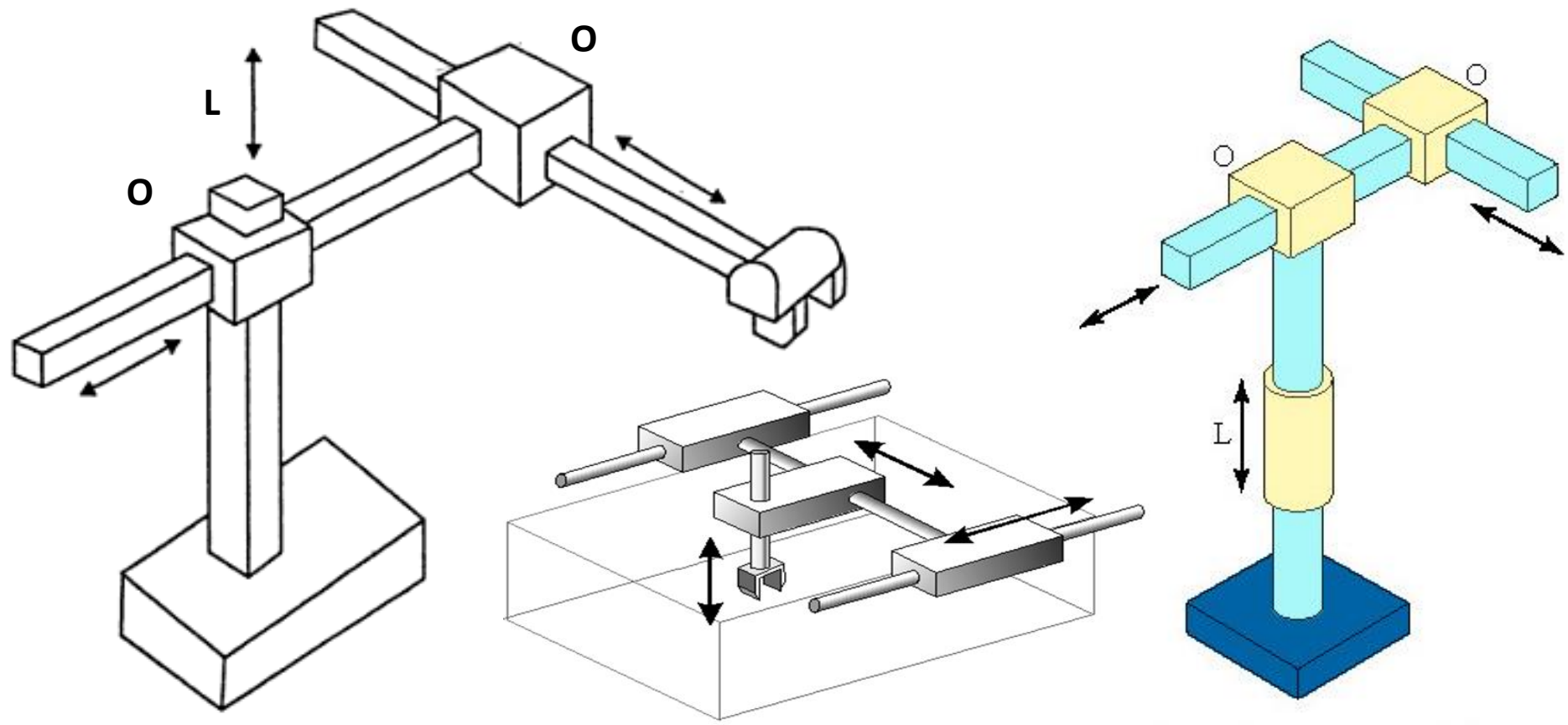
Basic Configurations of ROBOT

- ❑ **Work envelope** or **work volume** of a robot can be defined as the space within the end effector of the robot can operate or reach.
- ❑ Based on the coordinate system of motion of the manipulator and end effector, there are four basic configurations of robots:
 - 1) Cartesian Configuration Robots (LOO)
 - 2) Cylindrical Configuration Robots (TLO)
 - 3) Polar (Spherical) Configuration Robots (TRL)
 - 4) Jointed-Arm (Articulated) Configuration Robots
 - 1) Revolute Robots (TRR)
 - 2) SCARA Robots (VRO)

Basic Configurations of ROBOT

Cartesian Configuration Robots: (LOO)

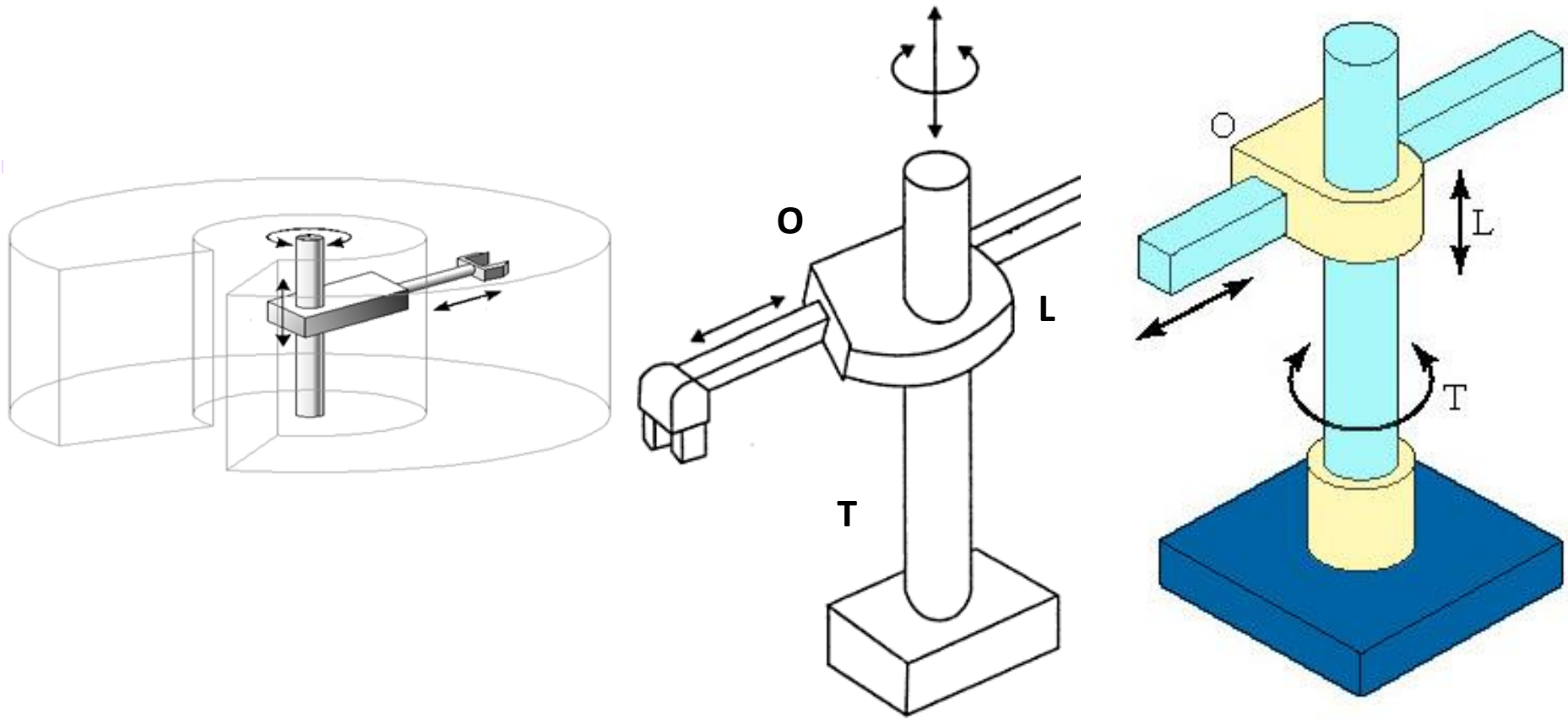
- Provides three linear motions along three mutually perpendicular axes: X, Y, and Z. However, there is no rotary motion.
- Configuration provides rectangular work envelope.
- Used for assembly, palletizing and machine tool loading.



Basic Configurations of ROBOT

Cylindrical Configuration Robots: (TLO)

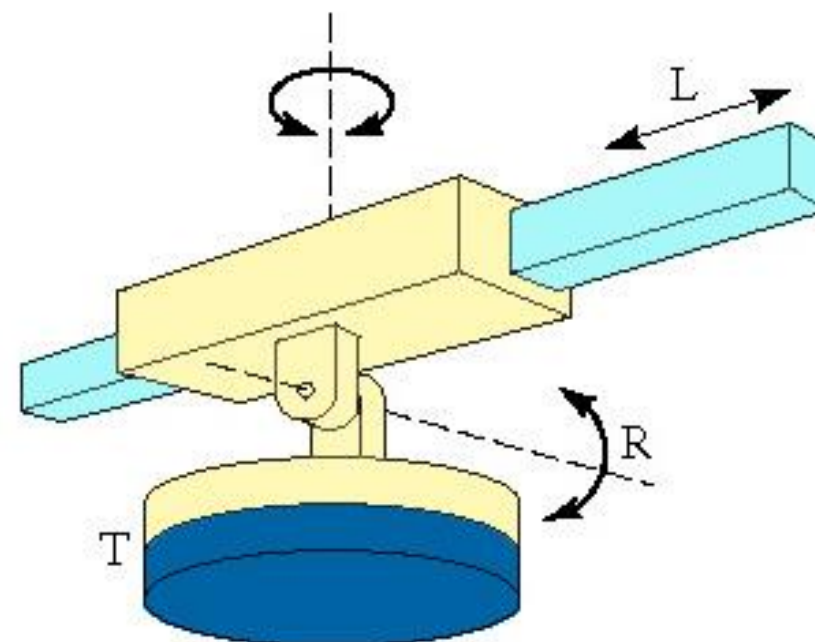
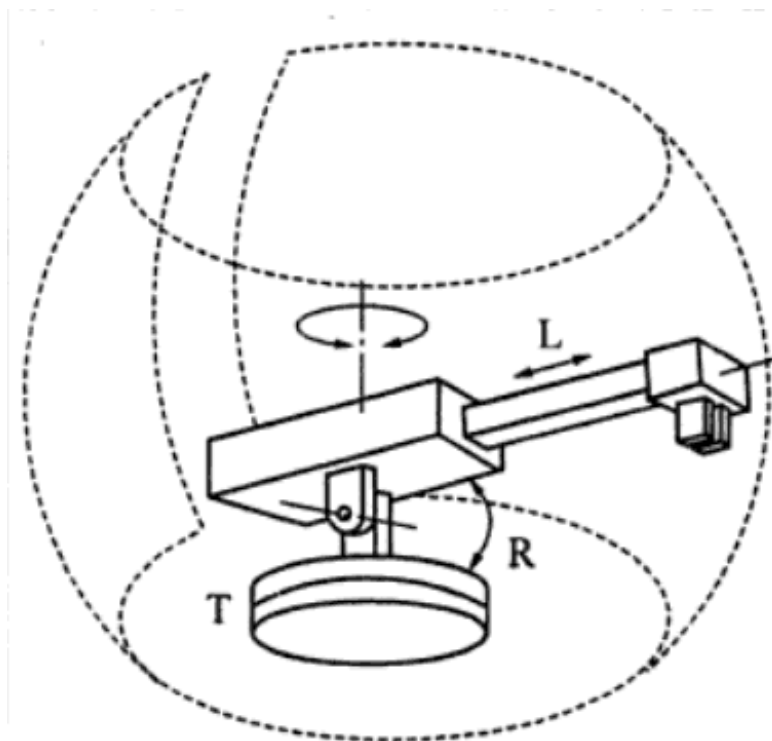
- Provides two linear and one rotary motions.
- Configuration provides cylindrical work envelope, has good work area to floor area ratio.
- Used for loading and unloading on machine tools.



Basic Configurations of ROBOT

Polar (Spherical) Configuration Robots: (TRL)

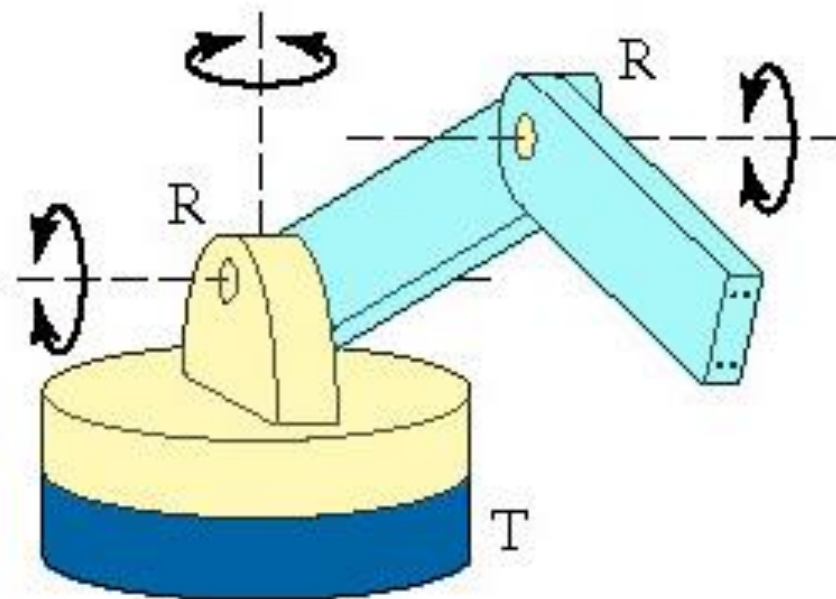
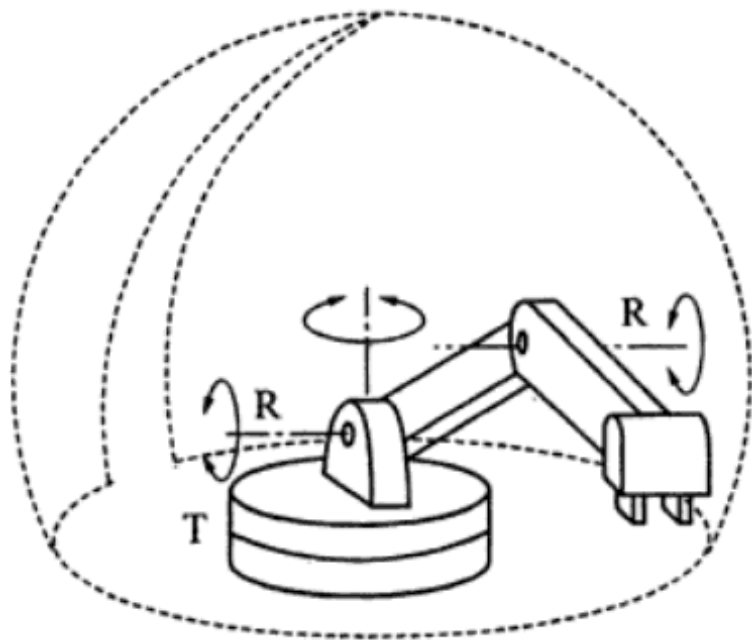
- Provides one linear and two rotary motions.
- Configuration provides spherical work envelope.
- Used for spot welding and manipulation (Handling) of heavy loads.



Basic Configurations of ROBOT

Revolute Robots: (TRR)

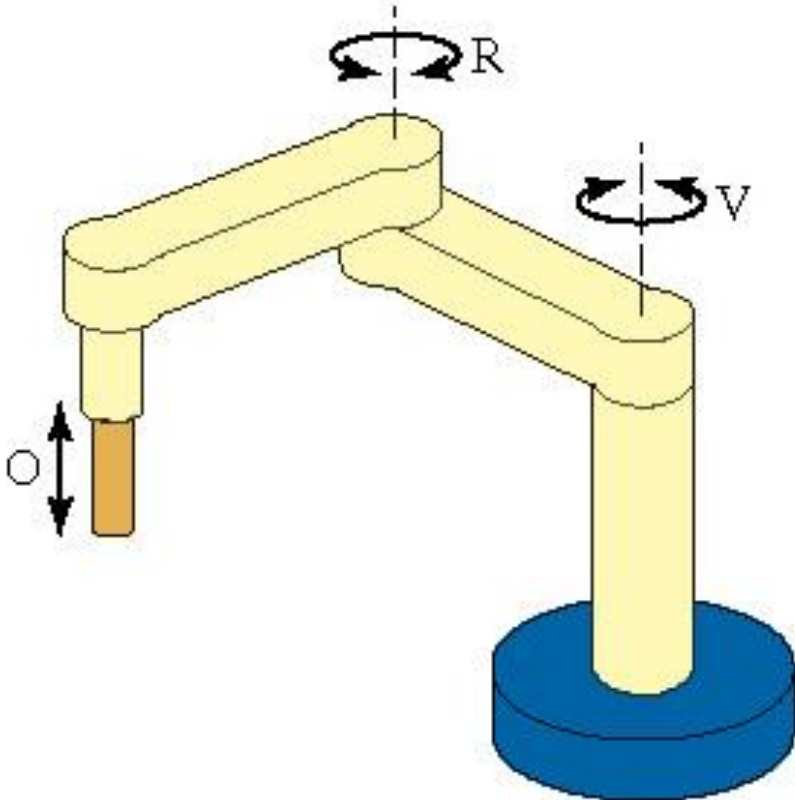
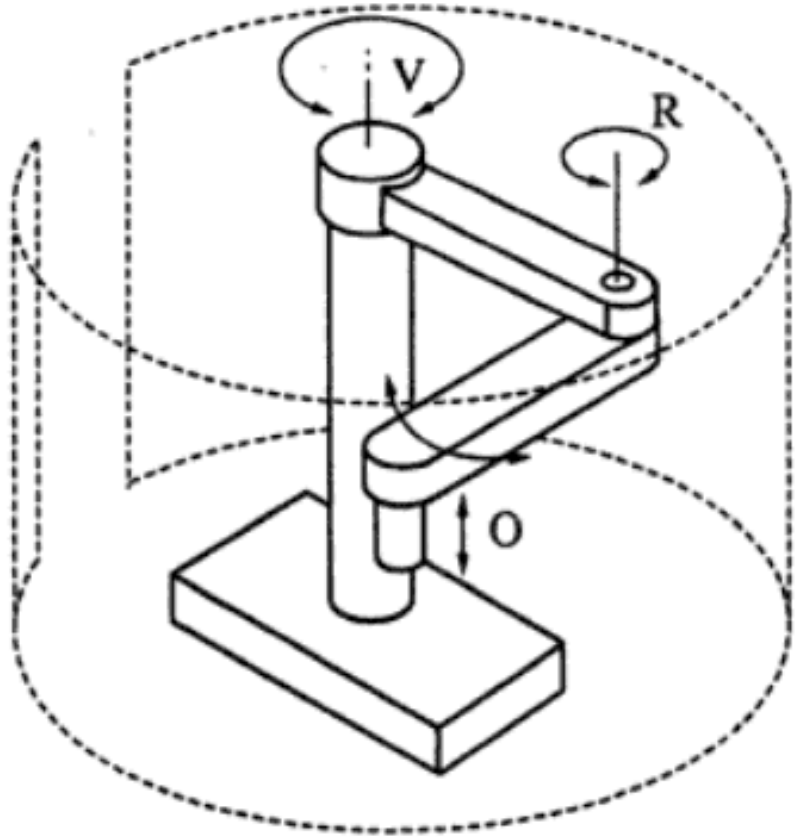
- Provides three rotary motions about three mutually perpendicular axes.
- Configuration is similar to that of human arm.
- Consists of two straight links, corresponding to the human forearm and upper arm, connected by a rotary joint.
- Provides spherical work envelope, has excellent work areas to floor area ratio.
- Used to spray painting, seam welding, spot welding, assembly, heavy material handling, etc.



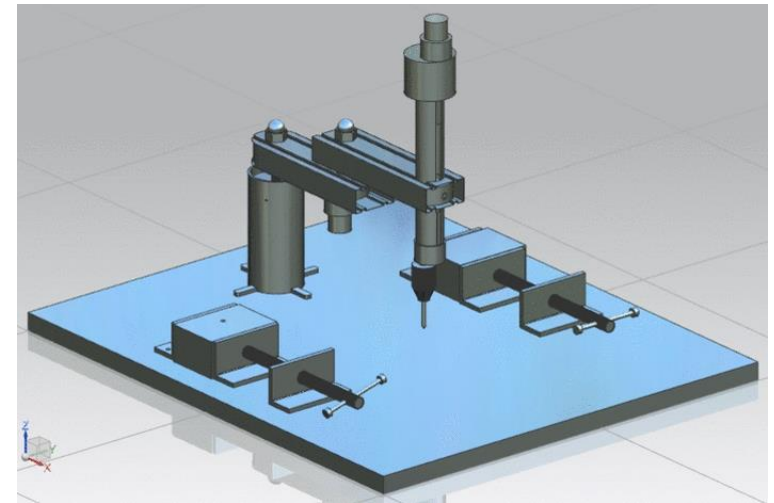
Basic Configurations of ROBOT

SCARA (Selective Compliance Assembly Arm) Robots: (VRO)

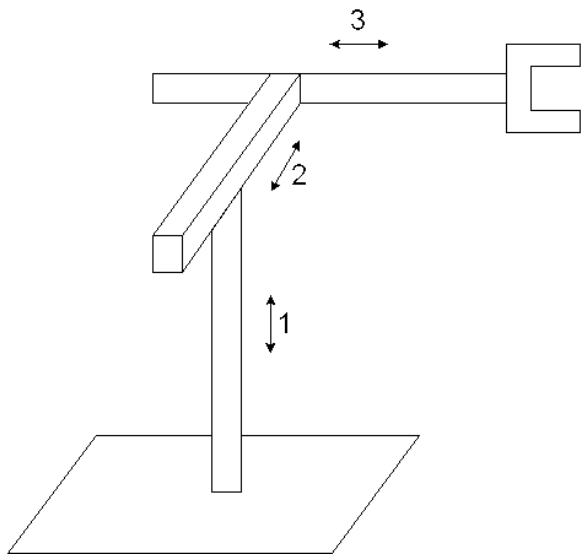
- Provides one linear and two rotary motions.
- Provides cylindrical work envelope with high speed drive motors.
- Used for assembly operations.



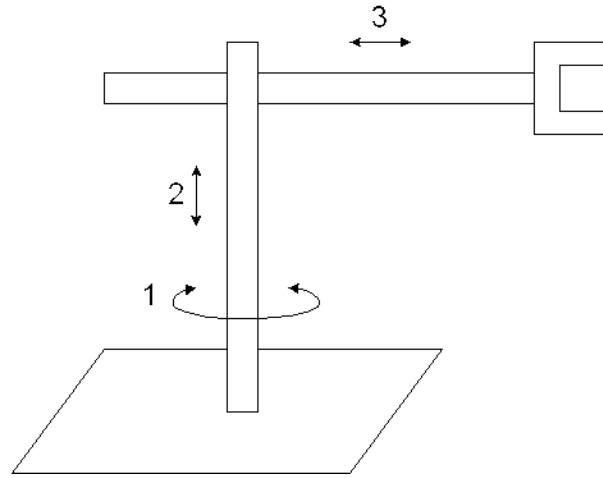
SCARA ROBOT



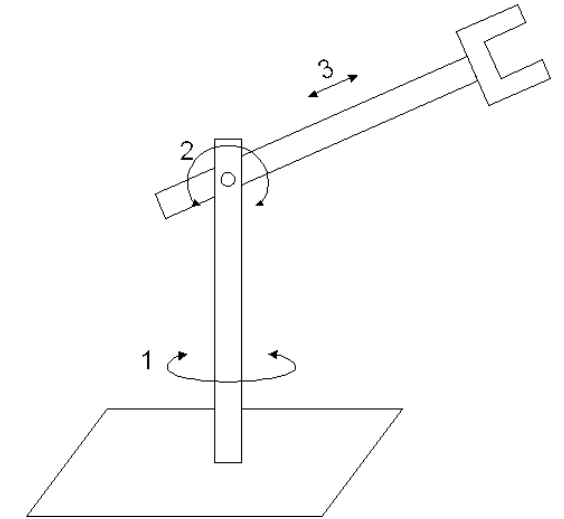
Basic Configurations of ROBOT



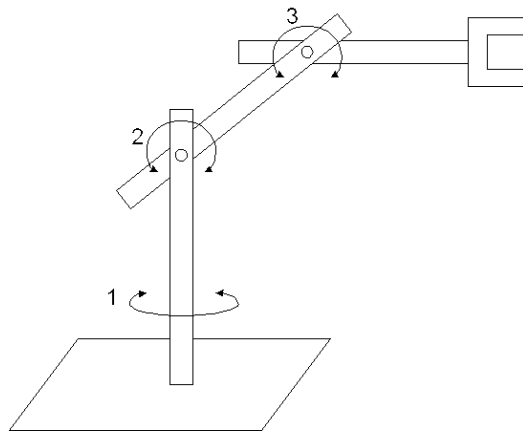
Cartesian: LOO



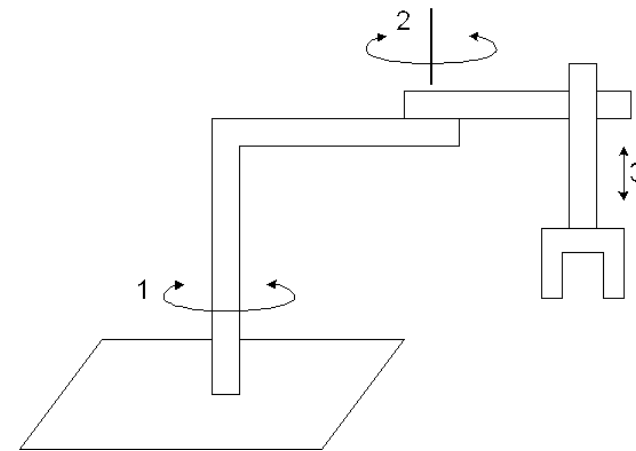
Cylindrical: TLO



Spherical (Polar): TRL

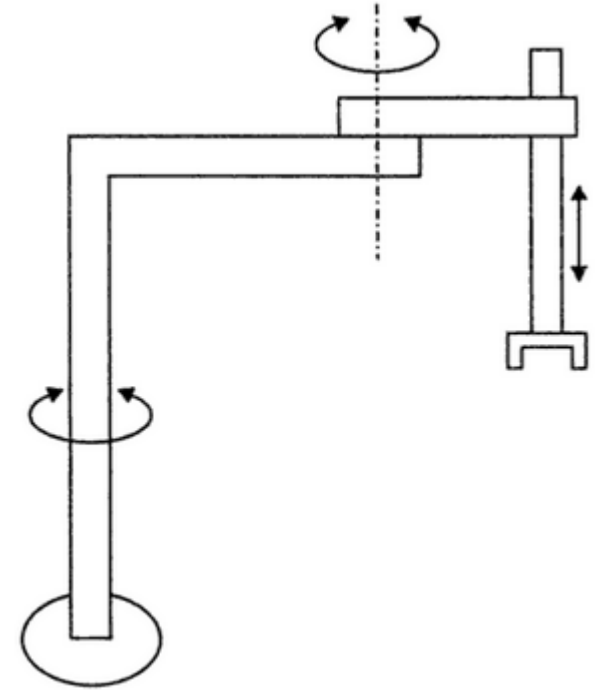
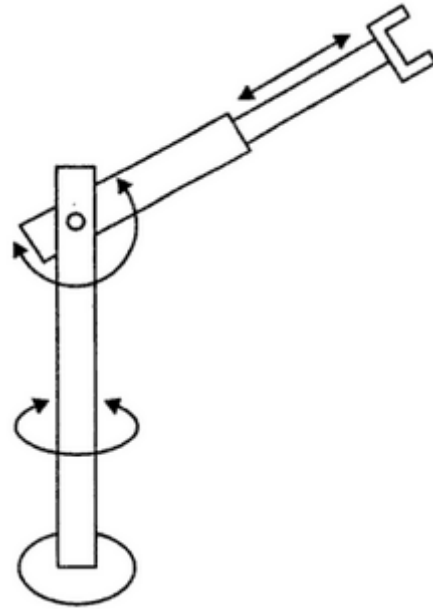
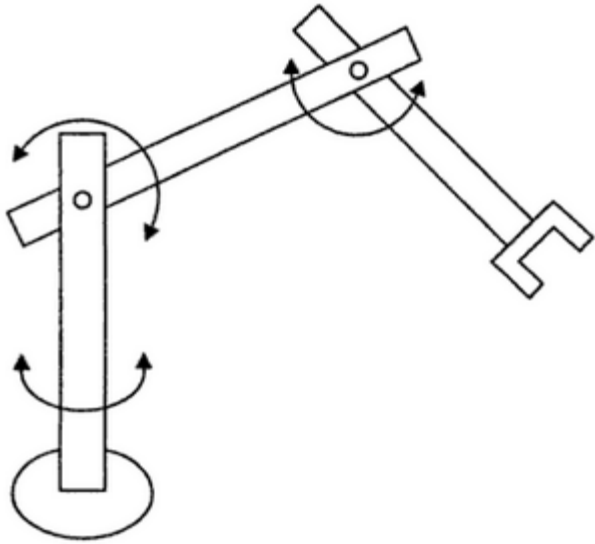
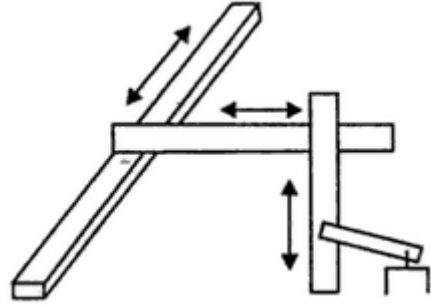
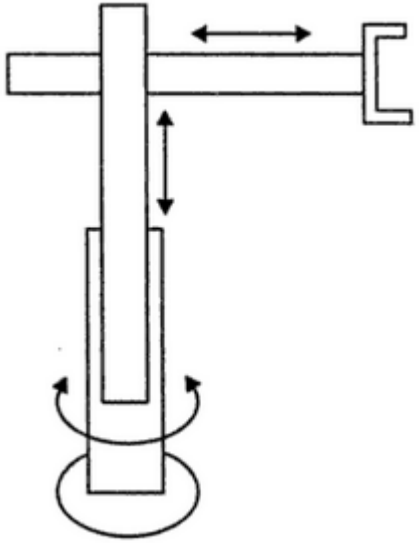


Revolute: TRR



SCARA: VRO

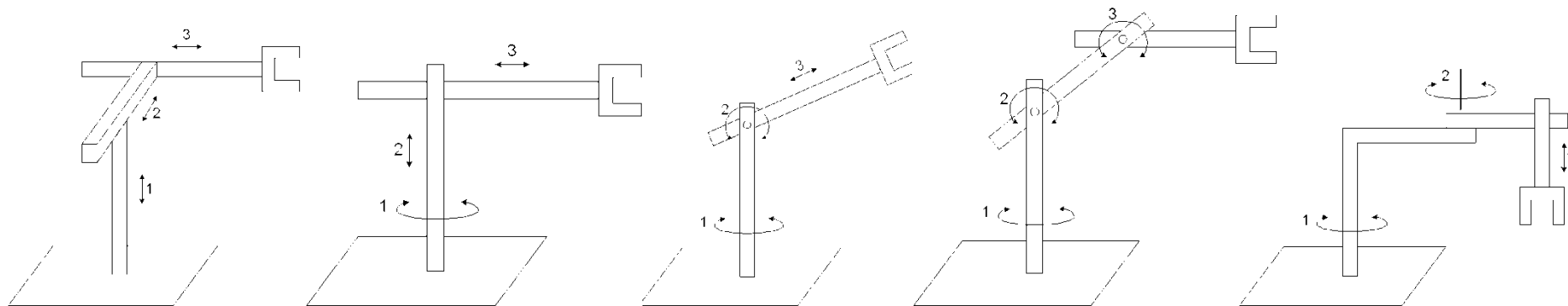
Basic Configurations of ROBOT



Basic Configurations of ROBOT

| Configurations | Manipulator | Motions | Work Envelope | Application |
|--------------------------|-------------|------------------------|---------------|--|
| Cartesian | LOO | 3 Linear | Rectangular | Assembly, Palletizing Machine Tool Loading |
| Cylindrical | TLO | 2 Linear , 1 Rotary | Cylindrical | Loading & Unloading on Machine Tools |
| Spherical (Polar) | TRL | 1 Linear , 2 Rotary | Spherical | Spot Welding , Handling of Heavy Loads. |
| Revolute | TRR | 3 Rotary | Spherical | Spray Painting, Seam Welding, Spot Welding, Assembly, Heavy Material Handling |
| SCARA | VRO | 1 Linear, 2 Rotary | Cylindrical | Assembly Operations |

L = Linear; O = Orthogonal; R = Rotational; T = Twisting; V = Revolving



Basic Configurations of ROBOT

| <i>← Features →</i> <i>Application</i> | <i>Degree of Freedom</i> | <i>Structure</i> | <i>Drive System</i> | <i>Program</i> | <i>Control System</i> |
|---|--------------------------|---------------------------------|---|--|---|
| Material Handling | 3-5 | Jointed arm | Pneumatic or Hydraulic | Manual or Powered lead through | Limited sequence or point-to-point playback |
| Machine Loading and Unloading | 4-5 | Polar, Cylindrical, Jointed arm | Electric or Hydraulic for (Heavy pay loads) | Powered lead through | Limited sequence or point-to-point playback |
| Spot Welding | 5-6 | Polar, Jointed arm | Hydraulic or Electric (light) | Powered lead through | Point-to-point playback |
| Arc Welding | 5-6 | Polar, Cartesian, Jointed arm | Electric or Hydraulic | Manual or Powered lead through | Continuous path playback |
| Spray Painting | 6 or more | Jointed arm | Hydraulic | Manual lead through | Continuous path playback |
| Assembly line | 3-6 | Jointed arm, Cartesian, SCARA. | Electric | Powered lead through or textual language | Point-to-point or continuous. |

Basic Configurations of ROBOT

| <i>Features</i> ↓ <i>Application</i> | <i>Degree of Freedom</i> | <i>Structure</i> | <i>Drive System</i> | <i>Program</i> | <i>Nature of Task</i> | <i>Control System</i> |
|--|--------------------------------------|--|---|--|--------------------------------|--|
| • Material handling | 3-5 | Jointed adaptable robot arm | Servo motors | Programmable automation control (PAC) | Safe/hazardous complicated | Motion controllers with sensor technology. |
| • Part loading and unloading | 4-5 Multiple arms | Polar, cylindrical, Jointed arm (Adaptable) | Electronic, Servo motors (For heavy payloads) | Programmable automation control (PAC) | Complicated and safe environs. | Micro controllers and Motion controllers with vision. |
| • Spot (Tack) Welding | 5-6 | Polar, Jointed adaptable robotic arm | Electronic stepper Motors. | Programmable Logic controllers (PLC) | Simple and safe. | Micro controllers with changeable functions. |
| • Arc Welding | 5-6 | Polar, modular cartesian with adaptable jointed arm. | Direct drive servo motors | Programmable automation control (PAC) | Complicated and unsafe. | Continuous path motion controllers with sensor technology. |
| • Spray Coating | 6 or more | Jointed arm with adaptable gun | Hydraulic actuators | Programmable Logic Controllers (PLC) | Simple and unsafe. | Continuous path motion controllers. |
| • Electronic Assembly | 3-6 Multiple arms coupled motion. | Jointed adaptable, cartesian modular robotic arm. | Stepper motors and direct drives | Programmable Automation Control with Controller area Network (CAN) | Complicated and safe. | Micro controllers, nodes with sensors and end effectors with vision. |

Assignment Questions

01 Draw neat sketches and explain various robot configurations. **or** Explain the term “Work Volume” with respect to robots and sketch configurations of industrial robots, showing work envelope.

07

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